

230067

FLOOD INSURANCE STUDY



CITY OF AUGUSTA,
MAINE
KENNEBEC COUNTY



OCTOBER 1, 1980



federal emergency management agency
federal insurance administration

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FLOOD INSURANCE STUDY
CITY OF AUGUSTA, MAINE

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Augusta, Kennebec County, Maine, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert Augusta to the regular program of flood insurance by the Federal Insurance Administration (FIA). Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

1.2 Coordination

Streams requiring detailed study were identified at an initial Consultation and Coordination Officer's (CCO) meeting on December 18, 1975, attended by representatives of the study contractor, the FIA, and the City of Augusta. During the course of the study, the work done by the Geological Survey (USGS), including the flood elevations, flood boundaries, and floodway delineations, was reviewed with community officials. An interim CCO meeting was held at the Augusta City Engineer's Office at City Hall on May 12, 1978, to review the study in progress.

On March 29, 1979, the results of the study were reviewed at the final CCO meeting attended by representatives of the study contractor, the FIA, and community officials.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were prepared by the U. S. Geological Survey for the Federal Insurance Administration, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 6. This work, which was completed in May 1978, covered all significant flooding sources in the City of Augusta.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Augusta, Kennebec County, Maine. The area of study is shown on the Vicinity Map (Figure 1).

Floods in Augusta caused by overflow of the entire reach of the Kennebec River, Bond Brook from its mouth to just upstream from Leighton Road, and the shorelines of Togus and Threecornered Ponds were studied by detailed methods. Also studied by detailed methods was Tributary A to Threecornered Pond which is affected by backwater from Threecornered Pond. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction for the next five years, through May 1983.

The following flooding sources were studied by approximate methods: Riggs, Tributary to Riggs, Whitney, Stickney, Spring, Stone, Fisher, and Sidney Bog Brooks; and Greeley, Anderson, Dam, Tolman, Spectacle, Lily, and Wellman Ponds. The Great Sidney Bog, Bond Brook, and Tributaries A and B to Bond Brook, above Leighton Road were also studied by approximate methods. Approximate methods of analysis were used to study those areas having low development potential and minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the FIA.

2.2 Community Description

Augusta is located in south central Kennebec County in southern Maine. The city is bounded on the north by the Towns of Sidney and Vassalboro, on the east by the Towns of Windsor and Whitefield, on the south by the Towns of Chelsea and Hallowell, and on the west by the Town of Manchester. The population of Augusta was estimated to be 21,945 in the 1970 census, an increase of 1.2 percent over the figures for 1960 (Reference 1). The land area of the city is 55.8 square miles with a population density of 393 people per square mile. Sixty-six percent of the city is covered by forest, 11 percent is used for agriculture and fields, 7 percent is wetlands, and 16 percent of the total area is developed (Reference 2).

Augusta, the capital of Maine, is the primary center of employment in Kennebec County. State offices as well as the numerous industrial and commercial establishments are the major employers. Many of the industrial and commercial establishments are located on

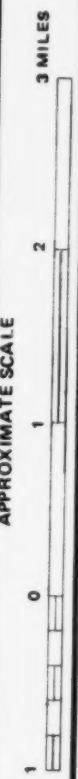




FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF AUGUSTA, ME
(KENNEBEC CO.)

APPROXIMATE SCALE



VICINITY MAP

FIGURE 1

the banks of the Kennebec River, which bisects Augusta. Several of these establishments are subject to flooding from the Kennebec River nearly every year.

The Kennebec River basin is located in west-central Maine and drains about one-fifth of the state. The Kennebec River originates at the outlet of Moosehead Lake and flows south for about 145 miles to Abagadasset Point in Merrymeeting Bay, where the Kennebec River is joined by the Androscoggin River and four smaller rivers before it flows for an additional 20.5 miles to the Atlantic Ocean.

The headwater lakes and streams that contribute to the Kennebec River flow through a mountainous region with peak elevations of up to 3,000 feet. The central portion of the Kennebec River Valley is characterized as an upland area of rounded hills having local relief of 1,000 feet. Below Waterville, the river valley widens, and the land elevations are generally less than 100 feet. Between Moosehead Lake and mean tide level at Augusta, the river falls 1,026 feet, an average gradient of 8.5 feet per mile. Below the Cushnoc Dam in Augusta, the Kennebec is a wide, tranquilly flowing river.

Bond Brook, a tributary to the Kennebec River, has a drainage area of 21.3 square miles. The brook falls approximately 100 feet from Leighton Road to its mouth, which is located just south of Cushnoc Dam. Several small commercial establishments and residential structures are located along Bond Brook.

Togus and Threecornered Ponds are both located in the eastern portion of Augusta. Although these ponds are relatively small they are used for recreational purposes. Along the shores of these ponds are located many seasonal and year-round dwellings.

Augusta has four major brook systems that drain the rural areas surrounding the city: Bond, Riggs, and Whitney Brooks, and Togus Stream. The Bond Brook system drains most of the area in Augusta located to the west of the Kennebec River. The brook drains a portion of the Great Sidney Bog as well as the surrounding hilly, wooded land and rolling fields. Both Riggs and Whitney Brooks flow from the area to the east of the Kennebec River. They originate in the low-lying terrain that is typical of the eastern part of Augusta. Before entering the residential portions of Augusta, Riggs and Whitney Brooks both tend to flow in a northerly direction; after entering the residential portions of Augusta, the brooks flow west to the Kennebec River. The remaining land area in the eastern part

of Augusta is typified by small ponds and large swampy areas which are undeveloped and quite inaccessible. This land is drained by Togus Stream, which is the outlet of Togus Pond. This stream begins at the Togus Pond Dam in Chelsea and flows south through the Townships of Randolph and Pittston to the Kennebec River.

The climate of Augusta is typified by moderately cold winters and mild summers. The average annual temperature is 45.1 degrees Fahrenheit (°F). The mean annual precipitation is 41.0 inches. Snowfall averages 77.0 inches annually. Since 1944 the seasonal snowfall has ranged from 29.5 inches in 1952-53 to 106.1 inches in 1955-56 (Reference 3). Water from snowmelt can be a significant source of streamflow during the months of March and April.

2.3 Principal Flood Problems

Flooding in Augusta occurs principally in the commercial area along the banks of the Kennebec River. Flooding usually occurs in the spring from rapid runoff as a result of unusually heavy rains combined with snowmelt. Flooding also occurs as a result of heavy rainfall associated with hurricanes.

Two of the most notable floods of recent history occurred in December 1973 and March 1936. The 1936 flood was the peak flood of record on the Kennebec River. Extensive damages as a result of this storm were experienced along the entire river. In Augusta, the 1936 flood level was 3 to 4 feet lower than the 100-year flood elevation published in this report (Figure 2). The 1936 event has a recurrence interval of 50 years. Since there are no gaging stations along this part of the Kennebec River, discharge values for these storms were not recorded. In 1973, the estimated flow in Augusta was 114,000 cfs, with a recurrence interval of about 10 years.

2.4 Flood Protection Measures

The natural streamflow of the Kennebec River is altered by several hydro-electric plants located upstream from Augusta. The structure that has the most pronounced effect on the Kennebec River is the dam at Solon, 66 miles upstream from Augusta. It is a low-head dam operated to maintain a discharge of 3,600 cubic feet per second (cfs) at Madison, 14 miles downstream. When inflow at the dam is more than 4,000 cfs, it no longer controls river discharges.

The most downstream dam on the Kennebec River is at the head of the tidal effect in Augusta. This low-head dam is operated for power

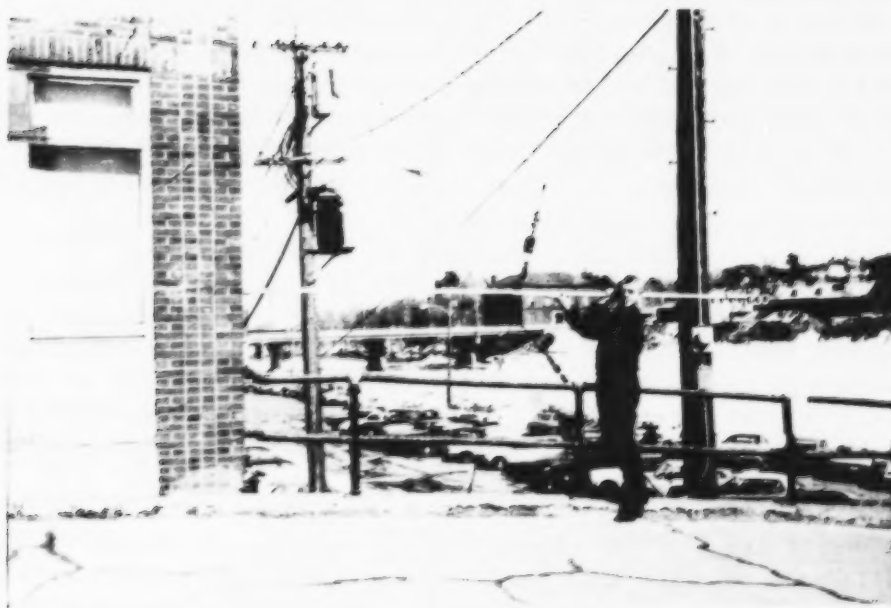


Figure 2 - The estimated height of the 100-year flood in the downtown commercial section on the west bank of the Kennebec River, just downstream from the Father Curran Bridge. The 100-year flood height determined for this location is 34.2 feet. (Photo by U. S. Geological Survey)

generation and to process water for mills. When the discharge at Augusta is more than 113,000 cfs, a 10-year flood, the dam is ineffective in controlling flooding downstream.

Augusta has adopted a shoreland zoning ordinance which covers most of the land within 250 feet of the normal high water of the major bodies of water in the city. This ordinance was enacted to restrict development and land use in the flood plain.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the city, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the flooding sources.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail in the city.

The Kennebec River is extensively controlled by reservoirs which are used primarily for the generation of hydro-electric power. The major storage lakes and their capacities in billions of cubic feet are as follows: Moosehead Lake 23.7, Indian Pond 3.2, Flagstaff Lake 12.0, and Wyman Pond 2.6. These reservoirs have a dampening influence on peak flows at Augusta.

The principal source of peak-flow data for the Kennebec River, downstream from Waterville, are records from the power plant operated by the Scott Paper Company at Waterville. The power plant records were published by the USGS as Station No. 01048500 at Waterville for the period 1892 to 1955. Records of maximum daily flows at this power plant for the period 1955 to 1977 were obtained from the Scott Paper Company.

Values of the 10-, 50-, 100-, and 500-year peak discharges at Waterville were obtained from the log-Pearson Type III distribution of annual peak-flow data (Reference 4). The results from this analysis were increased by 10 percent to simulate an instantaneous discharge because the peak-flow data for Waterville are values of maximum daily discharges. The 10 percent factor was determined to be the average amount by which instantaneous peak flows exceeded daily flows at Waterville. The factor was based on a comparison of 10 instantaneous peak discharges determined by flow of water over dam computations and the corresponding daily flow. Due to the difference in drainage area from Waterville (4,270 square miles) to Augusta (5,550 square miles), further increases in the peak flows were required. Stream flow records on the Sebasticook River, a tributary to the Kennebec, were the primary source of information from which the magnitude of these increases was determined. A linear regression analysis correlating simultaneous peak flows on the Kennebec and Sebasticook Rivers was made to determine the contribution of the Sebasticook River to the Kennebec during peak flood-flow events. For flood events of the magnitude considered in this report, no other significant sources of inflow to the Kennebec River exist between Waterville and Augusta.

The values of the desired magnitude flows for Bond Brook at the 10-, 50-, and 100-year recurrence intervals were obtained using equations developed by R. A. Morrill, whose methods are outlined in the U. S. Geological Survey Open-File Report 75-292 (Reference 4). These equations relate flood flows to the basin characteristics: drainage areas, main channel slope, and storage area in the basin. This method was also adapted for calculating flow for the 500-year recurrence interval. A summary of peak-discharges for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)				
		10-YEAR	50-YEAR	100-YEAR	500-YEAR	
KENNEBEC RIVER						
Augusta-Hallowell city line	5,550	113,000	159,000	179,000	227,000	
BOND BROOK						
At mouth	21.3	1,390	2,310	2,800	4,210	
At first crossing of Bond Brook Road	17.2	1,110	1,830	2,230	3,360	
Upstream of mouth of Stone Brook	13.7	898	1,500	1,820	2,760	

Analyses were also carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for the ponds studied in detail.

For Togus and Threecornered Ponds, the values of the desired magnitude flows at the two outlet dams for the 10-, 50-, and 100-year recurrence intervals were obtained using the methods outlined in USGS Open-File Report 75-292 (Reference 5).

Using these computed flows the elevations for the 10-, 50-, 100-, and 500-year floods were derived as explained in the following text.

During reconnaissance, all available information was collected for historical high-water elevations on the lakes, including accounts from long-term residents. The construction, operation, and maintenance of the outlet dams was also investigated in order to rate the dams. This investigation led to the conclusion that a sophisticated study of high water elevations in the lakes such as routing flows through the lake, would be misleading. The reasons are that

the dams are in poor physical shape and leak, the fish ladders and trash racks are seldom cleaned, and a log of gate changes rarely exists. The original dams at the outlets of both the ponds have been altered and dates of these changes were not recorded. Accurate elevation records have not been kept at either of the dams.

To determine stage-discharge relations for each of the outlet dams controlling the ponds, the study contractor made direct readings of pond elevations, surveyed the dams, and recorded their physical dimensions.

Reference points were set upstream of the dams so the head on the dams could be computed for observed and measured flows. Current-meter measurements were made at each of the outlet dams, and a relationship between stages and discharges was determined for each dam. These ratings were extended on the basis of the standard flow over dam formulas, Francis Formula ($Q = CLH^{3/2}$), Q is the discharge being studied, C is the coefficient of discharge, L is the length of the dam perpendicular to the direction of the flow, and H is the head on the dam (Reference 6). The measurements of flow to obtain values of " C " did not differentiate the flow for leakage or flow through deep gates. The coefficient of discharge was also determined using the tables and graphs in USGS Techniques of Water Resources Investigations, Book 3, Chapter 5, which lists " C " values for various dam types (Reference 7). The actual " C " value used in the Francis Formula to compute the flood elevation was based on both of these " C " determinations. The dams were rated as open when the " C " values were determined.

From the stage-discharge ratings drawn for the outlet dams, the elevations for the 10-, 50-, 100-, and 500-year floods were derived. The data from the analyses of water-surface elevations and frequencies for the ponds in Augusta are presented in Table 2.

TABLE 2 - SUMMARY OF ELEVATIONS

<u>FLOODING SOURCE AND LOCATION</u>	<u>PEAK ELEVATIONS (feet)</u>			
	<u>10-YEAR</u>	<u>50-YEAR</u>	<u>100-YEAR</u>	<u>500-YEAR</u>
TOGUS POND				
Within Augusta	183.7	184.1	184.3	184.7
THREECORNERED POND				
Within Augusta	196.1	196.7	197.0	197.5

All elevations computed were substantiated by interviews with life-long residents of the area, highway maintenance people and visual checks for washouts, ice scratch lines, and historical news releases. The analysis reported herein reflects the still water elevation but does not include the contributions from wave action effects such as wave-crest height and wave runup. However, the additional hazard due to wave action effects should be considered in planning of future development.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail in the city were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Cross-section data for the Kennebec River and Bond Brook were obtained by photogrammetric methods using aerial photographs taken on November 12, 1976 (Reference 8). The below-water data were obtained by field survey. All bridges and culverts were surveyed to obtain elevation data and structural geometry. The USGS operated temporary water-stage recorders in the Cities of Gardiner and Augusta from April to December 1976. The data obtained indicates that there would be less than a 0.1 foot tide effect for a discharge of 148,000 cfs in Augusta below the Cushnoc Dam. This flow has a recurrence interval of 40 years or an exceedance probability of .025. The 10-year flood profile shown on Exhibits 01P and 02P below the Cushnoc Dam could be as much as 0.5 foot higher in elevation in order to reflect the influence of normal high tide.

Roughness coefficients (Manning's "n") for the Kennebec River and Bond Brook were estimated on the basis of aerial photographs and field inspection at each cross section. Roughness values for the main channel of the Kennebec River were uniform and ranged from .035 to .040; the values for the overbank areas ranged from .040 to .100. Roughness values for the main channel of Bond Brook are variable and ranged from .035 to .055; the values for the overbank areas ranged from .035 to .090.

The computations for the Augusta study were done as part of the analysis of 18.2 miles of the Kennebec River which are part of the Flood Insurance Studies for seven Kennebec River communities, including Augusta and the Towns of Chelsea, Farmingdale, Pittston, and Randolph, and the Cities of Gardiner and Hallowell. The water-surface elevations for Augusta were taken from profiles developed

using the USGS step-backwater computer program model (Reference 9). These profiles were determined for the Kennebec River from river mile 29.8, the Pittston-Dresden town line, to river mile 48.0, the Augusta-Sidney town line.

The starting water-surface elevations used for the profile determinations were taken from recorded flood elevations and a convergence run using the step-backwater computer program. The backwater program was calibrated using profile information available from the 1936 flood (Reference 10). This calibration was possible because river conditions from 1936 to the present and the structures in the Kennebec River and their alignment have not changed appreciably. The computed backwater elevations of the Kennebec River at the mouth of Bond Brook were the source of the starting water-surface elevations used for the profiles on Bond Brook. These profiles are in agreement with historical flood marks.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 3).

For the streams and ponds studied by approximate methods, a regional stage-frequency relationship was determined and a 10-foot rise over the mapped stream elevation was estimated to be the inundation limit of the 100-year flood (Reference 11). The boundaries were delineated on USGS topographic quadrangle maps enlarged to a scale of 1:12,000 (References 12 and 13).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. Locations of the elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if the hydraulic structures remain unobstructed and dams and other flood-control structures operate properly and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using photogrammetric maps at a scale of 1:4,800 (Reference 14). In cases where 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 3). Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale and lack of detailed topographic data, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases

in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

As shown on the Flood Boundary and Floodway Maps (Exhibit 3), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 3.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "With Floodway" elevations presented in Table 3 for certain downstream cross sections of Bond Brook are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from the Kennebec River.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF's), and flood insurance zone designations for each flooding source affecting the City of Augusta.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE ¹	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Kennebec River								
A	200	900	31,900	5.6	32.4	32.4	33.4	1.0
B	1,390	750	27,800	6.4	32.6	32.6	33.5	0.9
C	2,840	470	19,700	9.1	32.6	32.6	33.6	1.0
D	4,580	680	27,500	6.5	33.7	33.7	34.7	1.0
E	6,480	820	29,900	6.0	34.1	34.1	35.1	1.0
F	7,520	460	20,100	8.9	34.2	34.2	35.1	0.9
G	8,260	370	16,000	11.2	34.2	34.2	35.1	0.9
H	8,780	470	19,700	9.1	36.1	36.1	36.9	0.8
I	9,110	610	23,900	7.5	36.5	36.5	37.4	0.9
J	9,690	860	31,500	5.7	37.6	37.6	38.4	0.8
K	10,830	830	32,200	5.6	37.8	37.8	38.6	0.8
L	11,630	910	31,400	5.7	37.8	37.8	38.6	0.8
M	14,490	660	23,700	7.5	38.2	38.2	39.0	0.8
N	17,540	540	21,700	8.2	39.1	39.1	39.8	0.7
O	20,510	600	22,900	7.8	40.0	40.0	40.7	0.7
P	22,850	620	23,300	7.7	40.7	40.7	41.4	0.7
Q	23,900	570	21,800	8.2	40.9	40.9	41.6	0.7
R	25,900	540	21,400	8.4	41.5	41.5	42.3	0.8
S	28,390	500	20,000	8.9	42.2	42.2	43.0	0.8
T	29,880	580	23,500	7.6	43.0	43.0	43.8	0.8

¹Feet above corporate limits

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Federal Insurance Administration

CITY OF AUGUSTA, ME
(KENNEBEC CO.)

FLOODWAY DATA

KENNEBEC RIVER

TABLE 3

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Kennebec River (continued)	31,330 ¹	560	22,200	8.1	43.3	43.3	44.1	0.8
	32,630 ¹	630	24,800	7.2	43.9	43.9	44.7	0.8
Bond Brook	1,880 ²	60	471	5.9	37.7	17.1 ³	18.1	1.0
	2,210 ²	170	808	3.5	37.7	21.9 ³	21.9	0.0
	2,650 ²	77	259	10.8	37.7	22.8 ³	22.8	0.0
	3,280 ²	50	375	7.5	37.7	26.6 ³	26.6	0.0
	3,500 ²	60	548	5.1	37.7	27.5 ³	27.6	0.1
	4,360 ²	120	936	3.0	37.7	28.5 ³	28.9	0.4
	5,040 ²	60	502	5.6	37.7	29.5 ³	30.0	0.5
	5,810 ²	120	725	3.9	37.7	31.0 ³	31.4	0.4
	6,350 ²	90	639	4.4	37.7	32.0 ³	32.2	0.2
	7,160 ²	330	491	5.7	37.7	34.2 ³	34.3	0.1
	8,250 ²	60	397	7.1	40.2	40.2	40.6	0.4
	9,250 ²	55	415	6.8	54.9	54.9	55.4	0.5
	10,360 ²	50	266	10.5	68.3	68.3	68.9	0.6
	10,830 ²	60	269	10.4	74.4	74.4	74.5	0.1
	11,280 ²	50	341	8.2	81.0	81.0	81.4	0.4

¹ Feet above corporate limits

² Feet above confluence with Kennebec River

³ Elevations computed without consideration of backwater effects from Kennebec River

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

FLOODWAY DATA

CITY OF AUGUSTA, ME
(KENNEBEC CO.)

KENNEBEC RIVER AND BOND BROOK

TABLE 3

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE ¹	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
Bond Brook (continued)								
P	11,850	100	587	4.8	91.6	91.6	91.7	0.1
Q	12,670	120	359	7.8	98.8	98.8	98.8	0.0
R	13,510	50	293	9.6	105.1	105.1	105.7	0.6
S	14,500	55	244	7.5	110.4	110.4	110.5	0.1
T	15,380	40	350	5.2	114.4	114.4	115.1	0.7

¹Feet above confluence with Kennebec River

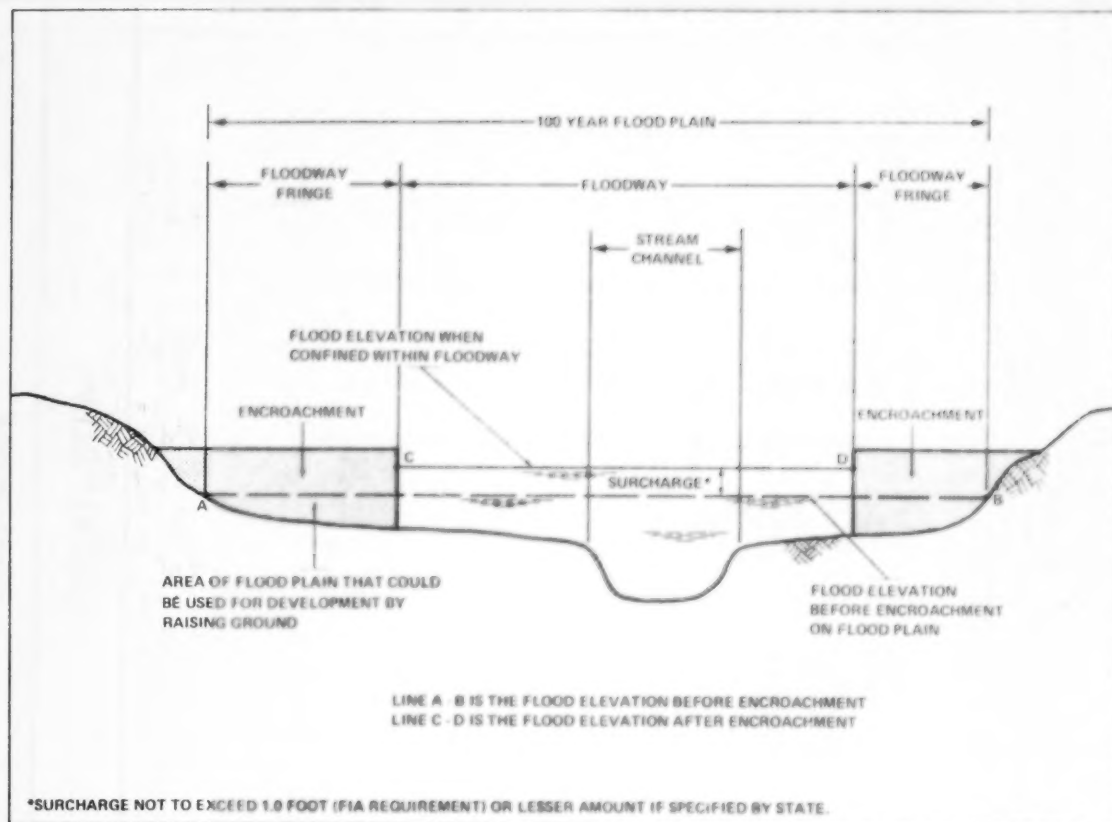
FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF AUGUSTA, ME
(KENNEBEC CO.)

FLOODWAY DATA

BOND BROOK

TABLE 3



FLOODWAY SCHEMATIC

Figure 3

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of reach. In lacustrine areas, reaches are limited to the distance for which the 100-year flood elevation does not vary more than 1.0 foot.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of reaches determined for the flooding sources of the City of Augusta are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 4).

5.2 Flood Hazard Factors

The FHF is the FIA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF's are used to set actuarial insurance premium rate tables based on FHF's from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between the water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, the accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determinations of reaches and their respective FHF's, the entire incorporated area of Augusta was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

- | | |
|------------------------------------|--|
| Zone A: | Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHF's determined. |
| Zone A1, A2, A5,
A12, A17, A18: | Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF. |
| Zone B: | Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also, areas subject to certain types of 100-year shallow flooding where |

FLOODING SOURCE	PANEL ¹	ELEVATION DIFFERENCE ² BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION ³ (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Kennebec River Reach 1	10,14	-8.3	-2.2	+5.1	085	A17	Varies
Reach 2	09,10	-8.8	-2.7	+6.8	090	A18	Varies
Reach 3	02,06,10	-6.2	-2.7	+6.4	060	A12	Varies
Bond Brook Reach 1	09	-2.4	-0.8	+2.0	025	A5	Varies
Togus Pond Reach 1	08,12,16	-0.6	-0.2	+0.4	005	A1	184
Threecornered Pond Reach 1	04,08	-0.9	-0.3	+0.5	010	A2	197

¹Flood Insurance Rate Map Panel

²Weighted average

³Rounded to the nearest foot - see map

FEDERAL EMERGENCY MANAGEMENT AGENCY
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FLOOD INSURANCE ZONE DATA

**KENNEBEC RIVER, BOND BROOK, TOGUS POND AND
THREECORNERED POND**

TABLE 4

Zone B: (continued) depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1.0 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 4, "Flood Insurance Zone Data," summarizes the flood elevation differences, FIFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the City of Augusta.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Augusta is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

In 1975, the U. S. Army Corps of Engineers made a Special Flood Hazard Information Report for the Kennebec River from the Dresden-Richmond town line to Augusta (Reference 15). The maps and profiles in the report define the boundaries and elevations of the 100- and 500-year floods. The profiles and flood delineations determined for Augusta by the USGS for this study are in exact agreement with the Special Flood Hazard Information Report for the 100-year recurrence interval. The differences in the 500-year flood elevations can be attributed to the different methods of analysis used in the two reports.

Flood Insurance Studies are currently being conducted for the Towns of Chelsea, Farmingdale and Manchester, which surround Augusta (References 16, 17 and 18). These studies are being conducted by the USGS, and the results of these studies will be in exact agreement with the data presented in the Augusta study. No other studies were found to exist at the time of this report.

This study is authoritative for purposes of the Flood Insurance Program, and the data presented here either supersede or are compatible with previous determinations.

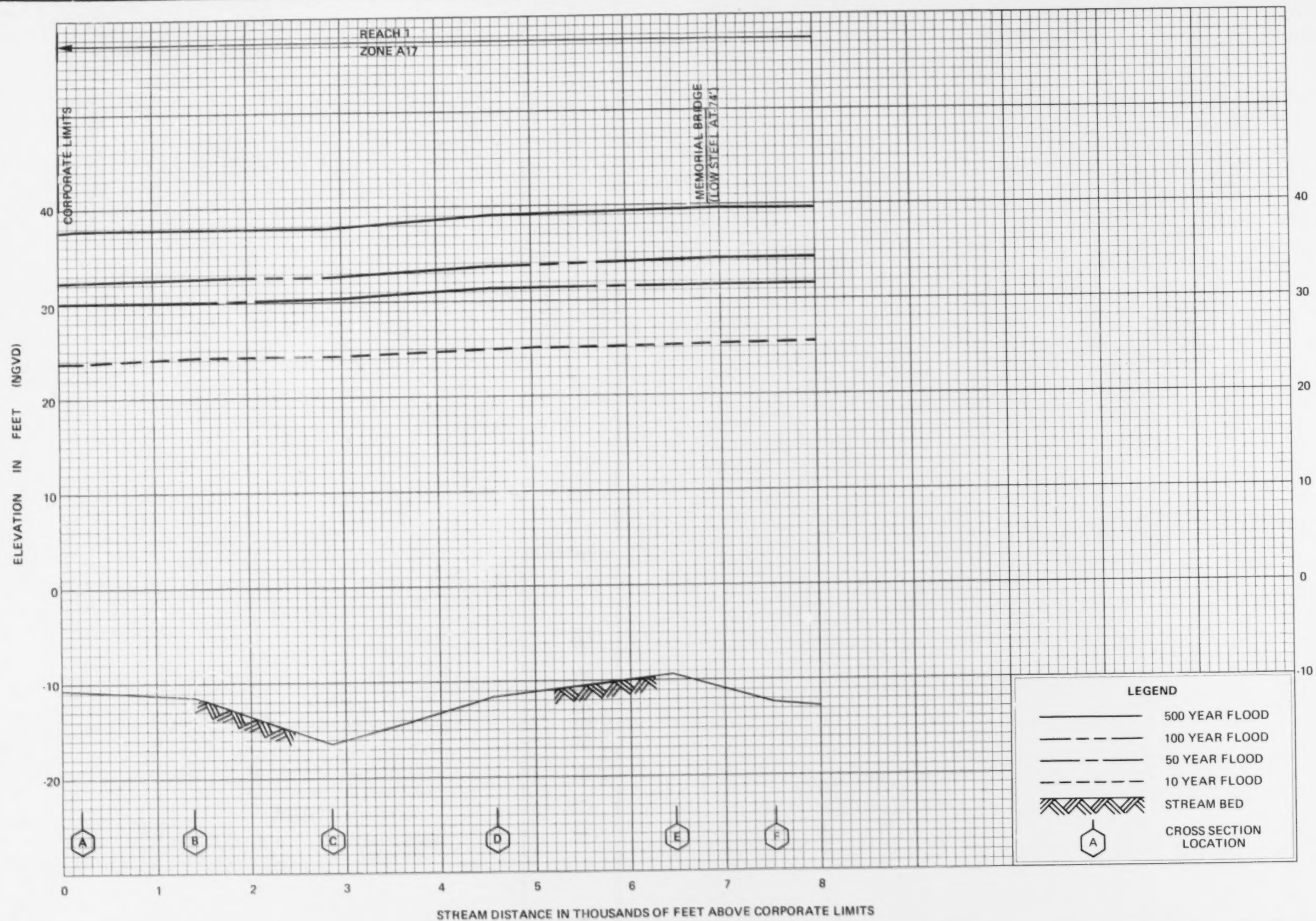
7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

8.0 BIBLIOGRAPHY AND REFERENCES

1. U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population, Number of Inhabitants, Maine, Washington, D. C., U. S. Government Printing Office, 1971.
2. Cobbossee Watershed District and Southern Kennebec Valley Regional Planning Commission, Water Quality Management Plan for the Southern Kennebec Valley, unpublished review draft, May 1977.
3. U. S. Department of Commerce, Weather Bureau, Climatology of the United States No. 20-17, Climatic Summary of the United States, Maine, Washington, D. C., 1961.
4. Water Resources Council, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, Washington, D. C., March 1976.
5. U. S. Department of the Interior, Geological Survey, Open-File Report 75-292, A Technique for Estimating the Magnitude and Frequency of Floods in Maine by R. A. Morrill, Washington, D. C., 1975.
6. J. B. Francis, Lowell Hydraulic Experiments, 5th Edition, D. VanNostrand Co., 1909.
7. U. S. Geological Survey, Techniques of Water Resources Investigations, Book 3, Chapter A5.
8. Hansa Engineering Corporation, Aerial Photographs, Augusta, Maine, Scale 1:6,600 or 1"=550, date of flight November 12, 1976.
9. U. S. Department of the Interior, Geological Survey, Open-File Report, Computer Applications for Step-Backwater and Floodway Analyses by James O. Shearman, Washington, D. C., 1976.
10. U. S. Department of the Interior, Geological Survey, Water-Supply Paper 798, The Floods of March 1936, Washington, D. C., 1937.

11. U. S. Department of the Interior, Geological Survey, "Methods of Determining Limits of Inundation by 100-year Frequency Flood for Flood Prone Area Maps," (Unpublished information developed by Augusta, Maine, sub-district office), 1972.
12. U. S. Department of the Interior, Geological Survey, 15-Minute Series Topographic Maps, Scale 1:62,500, Contour Interval 10 Feet: Augusta SE and Augusta NE, Maine (Provisional).
13. U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 10 Feet: Augusta SE and Augusta NE, Maine (Provisional).
14. Hansa Engineering Corporation, Photogrammetric Maps, Scale 1:4,800, Augusta, Maine, November 12, 1976.
15. U. S. Army Corps of Engineers, Special Flood Hazard Information Report, Kennebec River, New York, November 1975.
16. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of Chelsea, Kennebec County, Maine (unpublished).
17. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of Farmingdale, Kennebec County, Maine (unpublished).
18. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of Manchester, Kennebec County, Maine (unpublished).



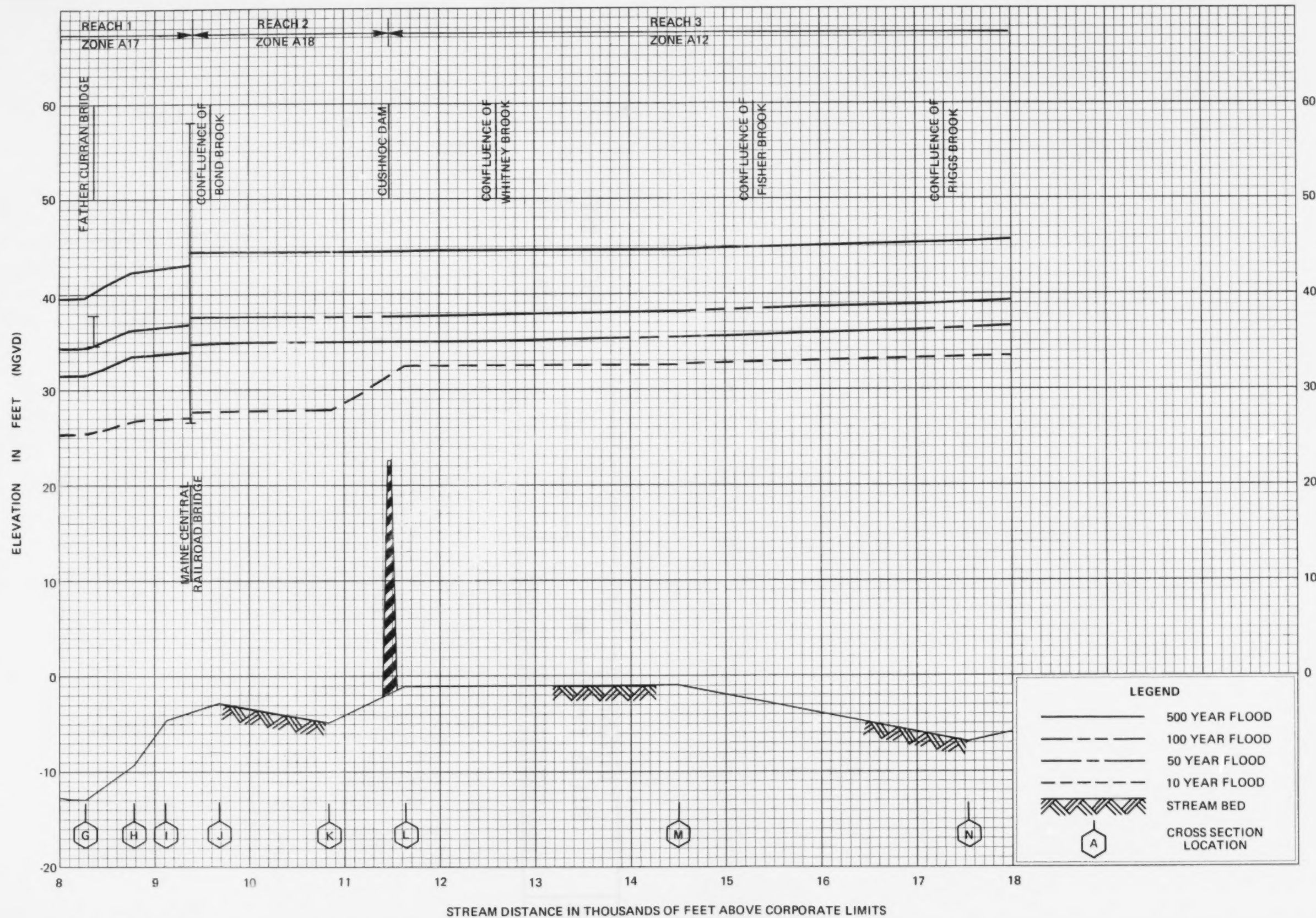
FLOOD PROFILES

KENNEBEC RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
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CITY OF AUGUSTA, ME
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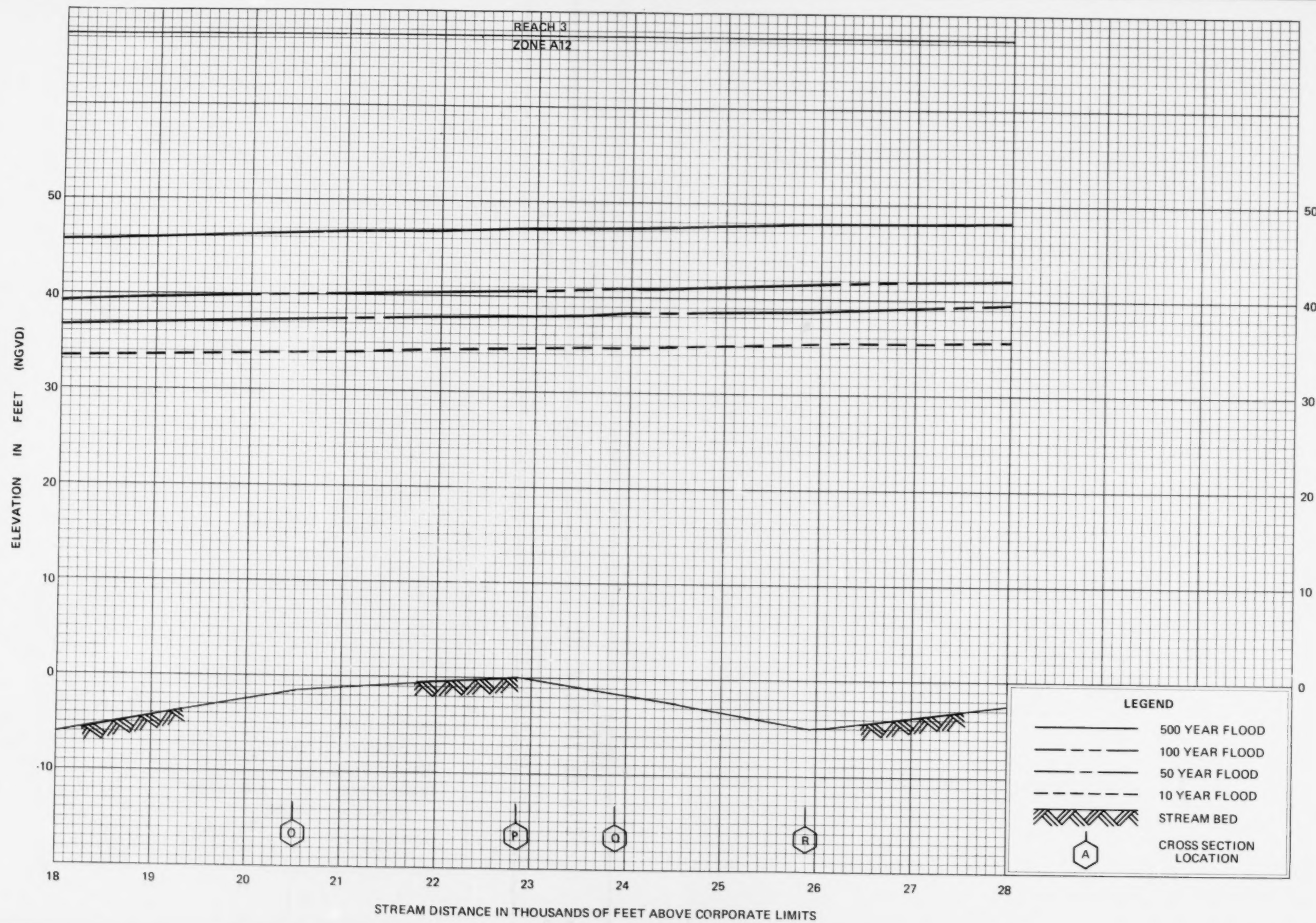
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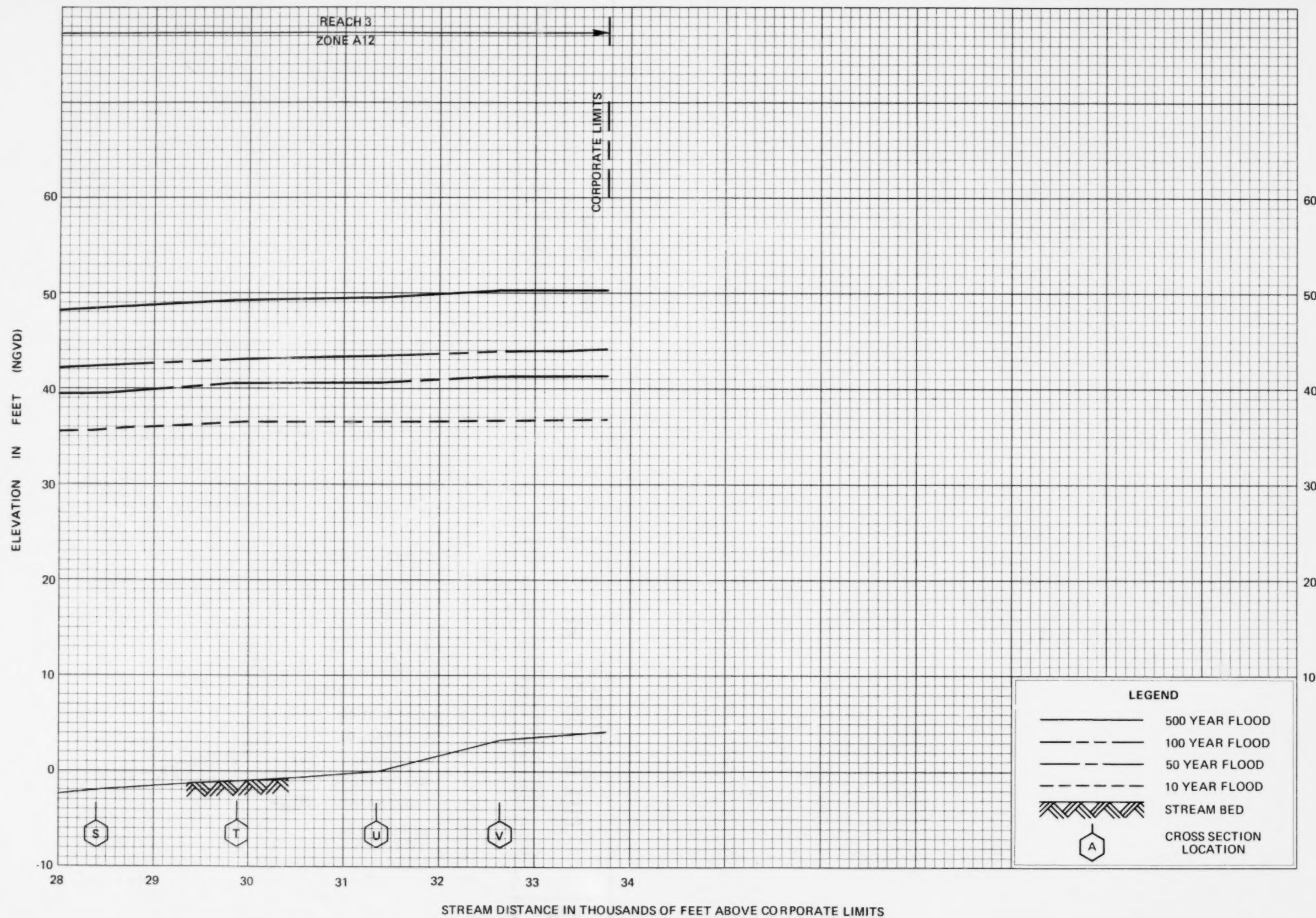
FLOOD PROFILES

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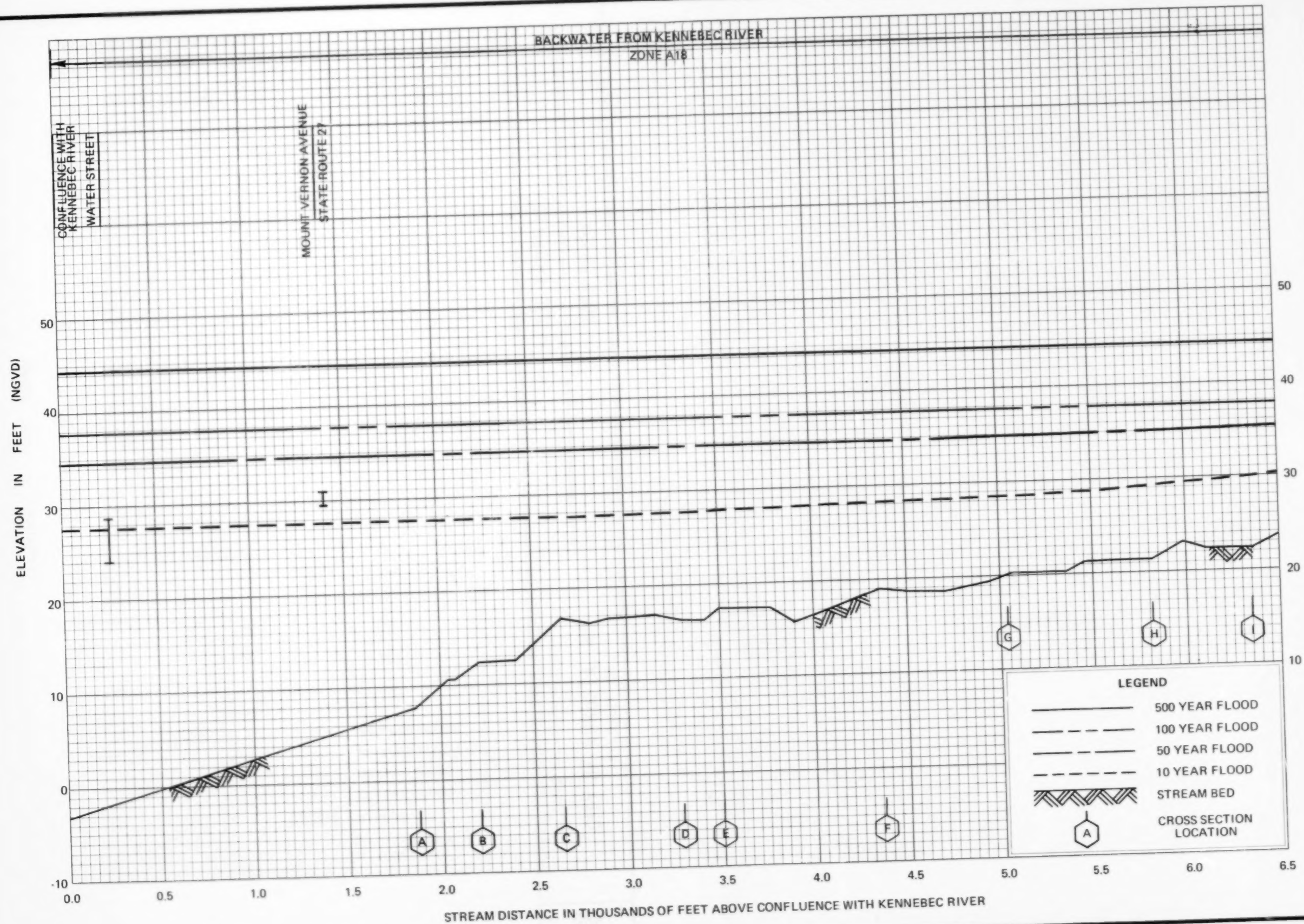
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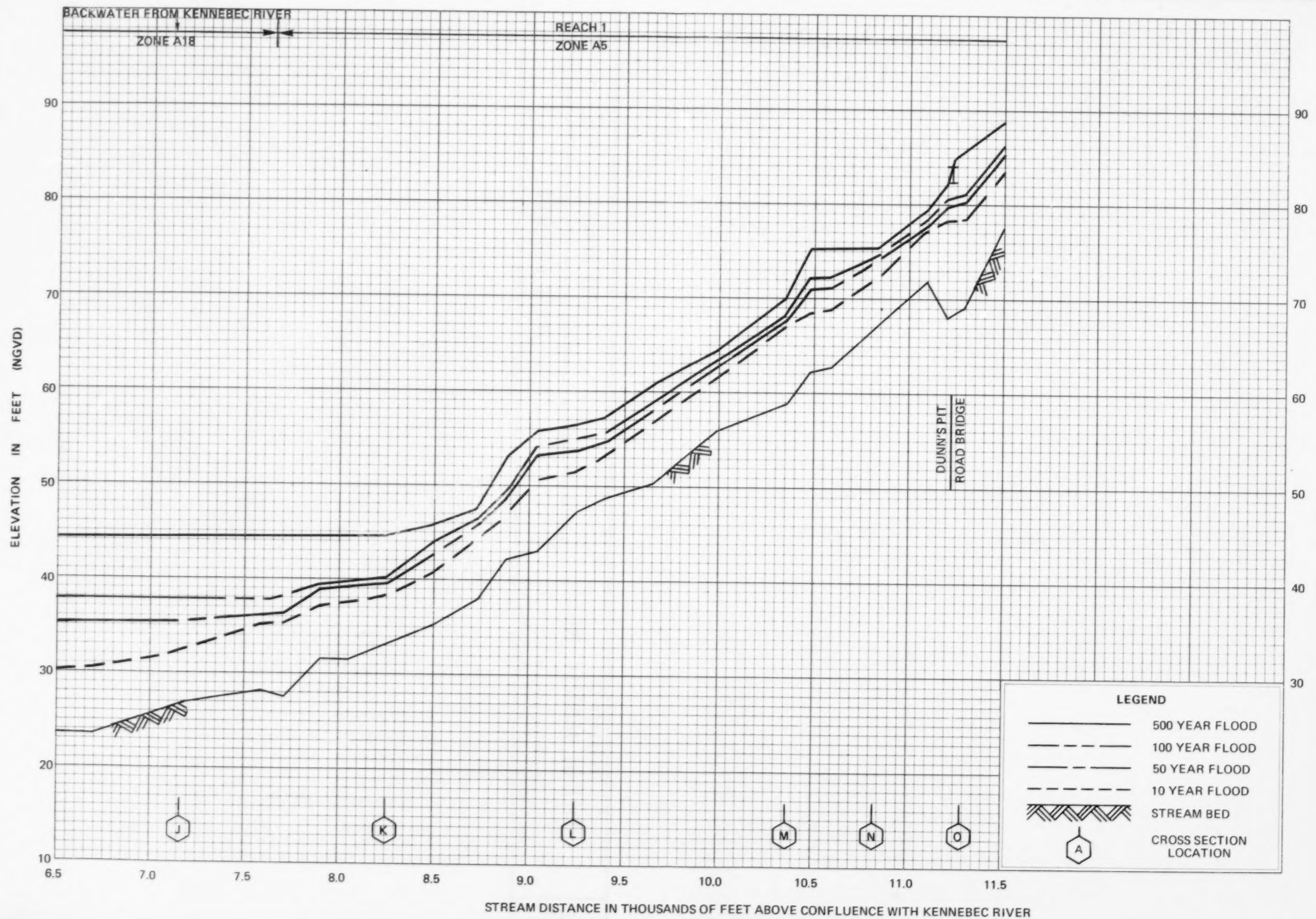
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